Materials Engineering Branch

TIP*

No. 046 Stress Corrosion Cracking in Copper Alloys

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Except for pure copper, a number of copper alloys are susceptible to stress corrosion cracking (SCC). For example brasses, Cu-Zn alloys with Zn content greater than 14% are among the alloys with the lowest resistance to SCC. Whether or not SCC will occur depends on many factors. The most important of them are the environment, the type and magnitude of the applied or residual stresses and their duration.

MSFC-STD-3029 document provides guidelines for selecting metallic materials, including copper alloys, resistant to SCC in sodium chloride environment and should be consulted when designing structural components and/or parts subjected to the mechanically or thermally induced stresses. If a specific application requires the use of an alloy with the low resistance to SCC, a Material Usage Agreement (MUA) should be initiated and submitted to the Materials Engineering Branch for approval. The process of generating an MUA is described in the Mission Assurance Guideline available on GSFC internal web site at: gdms.gsfc.nasa.gov/gdms.

In addition to sodium chloride environment, SCC in copper alloys has occurred also in pure and contaminated steam; in pure, polluted, fresh and sea water; in atmospheres and solutions containing ammonia; in aqueous solutions of amines, citrates, tartrates, nitrates, nitrites, sulfates, sulfites, sulfides, acetates, chromates, fluorides, and caustics; in UF 6 and in liquid metals, such as mercury, bismuth, lead, and some of their alloys.

Although some of the above environments are foreign to spacecraft applications, cleaning and processing agents may include some of them. For example, a trace of lauric acid in the dibutyl tin dilaurate (T12) catalyst of an RTV caused SCC in solar cell interconnects made of silver plated copper.

A critical part in the evaluation of the copper alloy for the possibility of SCC is the assessment of stress state, either applied or residual, the component is going to be subjected to during an assembly, testing and in storage. The applied stress normally can be calculated, but the residual tensile stress may be difficult to determine. Stress relieving treatments (mechanical or thermal) may be employed to reduce unknown, but suspected, residual stress. Otherwise, residual stresses can be detected in a destructive test, such as the ASTMB 154-71 mercurous nitrate test that detects high residual stresses. Another test, German Standard DIN-1785, determines if a copper alloy is susceptible to SCC in an ammonia environment at low residual stress levels.

In some cases, protective coatings or plating, if practical, could help to reduce a probability of SCC. Such coatings should be non-porous and should be flexible to prevent cracking if the substrate is subject to flexing. Once the hardware is placed into orbit where the environment disappears, the SCC will be inhibited unless the susceptible component is in a hermetically sealed enclosure with moisture and a corrosive agent present.

References:

"Mission Assurance Guidelines (MAG)) for Tailoring to the Needs of Goddard Space Flight Center (GSFC) Projects", June 24, 2002. Directive # 300-PG-7120.2.2B.

"Guidelines for the Selection of Metallic Materials for Stress Corrosion Cracking Resistance in Sodium Chloride Environment", MSFC-STD-3029, effective May 22, 2000.

"Stress Corrosion Cracking of Copper-base Alloys ", by Markus 0. Speidel, Ohio State University., Draft of ARPA Handbook on Stress Corrosion Cracking. Note: This reference should be verified to see if a handbook had already been published.

"Stress Corrosion Cracking Control Measures", by B. F. Brown, American University, NBS Monograph 156, June 1977

"Standard Method of Mercurous Nitrate Test for Copper and Copper Alloys, II ASTM B 154-71